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THE SUBSTRUCTURE OF AGRICULTURE

The fundamental relation of botanical science to all lines of agriculture—indeed the practical identity of them—is strongly brought out in an address by Dr. William Trelease of Illinois University, of which the following is an excerpt:

> It is not so very many years since in an agricultural college one man served as Professor of botany, of horticulture and forestry, though agronomy as a part of plain agriculture even then stood by itself. Today if more than one of these subjects be found in a department it is usually for reasons of administrative correlation rather than because of their consanguinity.
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> Like agronomy, these specialties all rest on a knowledge of the structure and the work and the environmental relations of plants, all of which conform to laws that form a part of the science of botany and that, under whatever name, have been framed by botanists.
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> One might almost venture the assertion that whether called a clerical, like Mendel, a farmer, like Lawes, a horticulturist, like Burbank, or an unclassified naturalist, like Darwin, all those men who made great economic plant-industry advances have been in reality botanists.
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> If I were to sum up in general terms the relations of botany to agriculture in college, I should say that, whether called genetics or agronomy, every fundamental step in plant breeding is botany; whether called floriculture or olericulture, every recognition of mutation and every selection based upon it is botany; whether called fighting weeds, in agronomy, or reseeding the wood-lot, in forestry, every ecologically grounded procedure is botany; whether you practice prophylaxis or quarantine or bring into existence resistant races, every step in combating plant disease is directly applied botany, and even the season for most satisfactory pruning, the selection of full-weight seeds and the proper utilization of those that are under-ripened, all rest on botanical discovery brought about—under whatever name you like—by botanical investigation.
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> The day may come, possibly, when we shall place all such botanical studies in the hands of doctors of agronomy or doctors of olericulture or doctors of pomology; but learned as the agronomists and olericulturists and pomologists and other specialists are who are adding untold wealth to the country every year through their specially trained and concentrated skill, it appears that today for the most part these men actually are doctors who have taken their major work in botany, and minor work only in the paramount field within which they planned to apply their training in this fundamental science. The relation is somewhat that between discovery and invention—with larger financial rewards on the applied side.

THE FARMER

The glory of the farmer is that, in the division of labors, it is his part to create. All trade rests at last on his primitive activity. He stands close to Nature; he obtains from the earth the bread and the meat. The food which was not he causes to be. The farmer was the first man, and all historic nobility rests on possession and use of land. Men do not like hard work, but every man has an exceptional respect for tillage, and a feeling that this is the original calling of his race, that he himself is only excused from it by some circumstance which made him delegate it for a time to other hands. If he have not some skill which recommends him to the farmer, some product for which the farmer will give him corn, he must himself return into his due place among the planters. And the profession has in all eyes its ancient charm, as standing nearest to God, the first cause.

—*Ralph Waldo Emerson.*

CURING HAM AND BACON FOR HOME USE[1]

By Mariano Mondoñedo
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INTRODUCTION

That the diet of the Filipino people, that is, the masses, is below standard in quantity and variety is a statement no longer questioned. To remedy this condition by bringing important food products now enjoyed by a few within the means of many should be an aim of agriculturists. Bacon and ham are food products that should be within reach of the majority, as hogs are raised in most parts of the country and the use of pork is common. But only imported ham and bacon are consumed. Being imported, the price of this healthful and palatable food is so high that only a few people can buy it; there is practically no domestic product.

For lack of methods of preservation, pork is consumed by most Filipinos in only one form, fresh. There is no cured pork. As fresh pork can be kept only a few hours, people are forced to consume the surplus of supply instead of putting it away for future need. It is literally a "feast or famine". Of course, the production of pork has to be limited to supplying it in a fresh state only. This limited demand is probably one of the reasons why the hog industry in this country remains in an undeveloped stage.

This condition of the hog industry and the uneconomic consumption of pork are realized in the College of Agriculture. To help remedy both, effort has been made to find a method for producing bacon and ham, primarily for home consumption, that would be easy to follow and the product cheap enough to place it within the means of most farmers' families, at least. Judging from the results obtained from trials made, the preparation of ham and bacon in small quantities is not only possible but economical and practical. It is hoped that in the future, poor farmers and well-to-do farmers who live far from the market, may break the monotony of a meat diet of dried salted fish. For, by raising a few pigs or by buying some fresh pork and taking the trouble, they can make their own ham and bacon.

To prevent misunderstanding, a word of explanation may be necessary as to the use of the words "ham" and "bacon" in this paper. The word ham is not limited to the thigh or bacon to the side meat, but to the parts where the fat and the lean meat are held together by firm connective tissue. It has been found in our experiments that when the lean separates and hangs loosely on the fat part the meat will not cure properly. As our product is similar in quality to the standard ham and bacon in the market we use the terms because the Filipino farmer knows smoke-cured pork only from the imported commercial product.

As a number of requests for the recipe which we have found successful at this College have come in, it was decided to publish the process for distribution. We hope by so doing, (1) to render a service to the hog industry in the Philip-

[1] Experiment Station contribution No. 250.

pines; (2) to better the diet of our farmers; and (3) to enroll the help of those interested by way of giving us suggestions based on their experience under conditions differing from ours, and by so doing, contribute to the perfection of the process of curing ham and bacon and to the establishment of a new industry in the Philippines.

It is suggested that for the first trial in curing pork, one should begin with small pieces, say one-third to one-half kilogram, and in small quantities. Good results have been obtained from curing meat from carcasses of hogs slaughtered for market purposes.

Meat cured during the rainy season is likely to get moldy so it should not be kept too long. Moldy hams after being scraped off are good for boiling and for flavoring foods, such as *puchero, relleno*, etc.

Ham cured without the use of ice, if carefully done, compares favorably with the imported ham, commonly called *de funda*. For frying it is superior to the Chinese ham.

Shrinkage up to the end of the curing process is about 20 per cent of the initial weight of the meat. It will cost from 3 to 5 centavos for brine ingredients to cure 1 kilogram of pork. At ₱1.00 for a kilogram of pork, plus 4 centavos for brine ingredients, .8 kilogram of ham costs ₱1.04, or a kilogram of ham thus made costs ₱1.30, approximately.

SLAUGHTERING THE HOG

SELECTING THE ANIMAL

The best ham and bacon are obtained from quick growing pigs. A pig of this kind, barrow or gilt, 8-16 months old, that has been rather closely confined and fed on rations for both growth and fattening, should give a tender succulent ham and bacon that is evenly marbled with fat. The best native pigs so fed and managed should weigh about 60 kilograms at 10-12 months old. Under the care and management usually given, this kind of a pig may not attain this weight before the age of 18 months. Above all, the pigs must be free from any ailment or disease, a condition required by law for all hogs butchered.

PREPARATION BEFORE KILLING

The animal should be fasted 24 hours before killing but should be given plenty of clean fresh water to drink. This treatment will help to free the blood and tissue cells from freshly assimilated substances which weaken the keeping quality of the meat. It will cause the animal to bleed more freely and completely, hence the meat when placed in the brine will more readily absorb the curing ingredients.

A good place to keep the hog while fasting is in a pen or crate in a quiet place so that it will not be excited, thus the body temperature will stay normal, otherwise the blood vessels may remain dilated after slaughtering, which causes poor bleeding. In getting the hog into the pen, in catching and casting preparatory to sticking, avoid rough handling so as not to cause bruises, contusions and the like, which may serve as points for the beginning of a feverish condition. Moreover, as it is dead flesh, if a bruised spot is cured, it will serve as a point for souring or putrefaction to start.

TIME TO SLAUGHTER

For curing purposes, the best time to slaughter a hog is late in the afternoon (6:00 p. m.) so that the meat can cool thoroughly during the night. However,

if the hog is to be killed primarily for market purposes and only a small portion is to be cured, the slaughtering should be done very early in the morning, from 4:00 to 5:00 a. m. The best time of the year to slaughter for curing purposes is during the cool season; that is, between November and February.

MANNER OF STICKING

One object to be kept in mind in sticking is to secure a thorough bleeding. This can be accomplished by sticking the animal so that the two principal blood vessels on each side of the neck are severed at the point where they unite, which is at the region opposite or a little behind the first pair of ribs. The knife is inserted, edge toward the neck, and pushed till the point of the knife has penetrated three or four centimeters behind the point of the breast-bone, then the point of the knife is thrust directly downwards to the neck at its junction with the backbone. In this manner the two large blood vessels are cut leaving the heart uninjured so it will pump the blood out. It is very necessary that the heart be left uninjured in sticking.

There are many ways in use to promote good bleeding. One way, rather common among farmers in America, is to let the animal stand as soon as it is stuck and let it bleed to death.

The method of slaughter used at the College is to confine the animal in a crate while fasting. Just before killing, one of the hind legs is tied with a piece of rope with a loop at the free end. This loop is hooked or tied to a long piece of rope and the animal is hoisted to a convenient level. With a block and tackle this can be done by one man. While the pig is hanging, the two fore legs, extended forward, are tied with a short piece of rope passed over the back of the neck. The pig can then be stuck with little or no difficulty. The advantages of this method are that there is no struggling with the pig, thorough bleeding is secured, and one man can perform the whole operation.

DRESSING THE CARCASS

The most approved way of scalding is by immersion. Meat that has been subjected to too much scalding will not cure well. The right temperature of the water should be between 65° C. to 70° C., (150° F. to 160° F.) When a thermometer is not available, temperature may be tested, approximately, by dipping a finger in the water three times; if the pain is severe after the third dipping the water may be considered about right. The carcass should be kept in motion while in the hot water so as to have every part subjected to an equal temperature.

The operation of scalding is greatly facilitated by the use of a block and tackle. A barrel or a large vat, *kawa,* may be used for the purpose. In case the carcass is too large for the barrel or vat the hind quarters may be immersed and scraped first, then the fore quarters. The carcass should be kept under water long enough that the hair can be rubbed off with the hands. By this process of scalding, the carcass is not subjected to much handling, and if the scalding water is at the proper temperature it is not kept immersed too long.

Clean first the head and feet, then the body. After the whole body has been scraped clean, rinse with hot water; shave off any remaining hair with a sharp knife; finally rinse with cold water and dry the surface by scraping with the back of a knife.

After scraping, remove the internal organs as quickly as possible to prevent the odor of their contents spoiling the flavor of the meat.

CURING THE MEAT

SELECTION OF PARTS

When ice is not used, only small pieces can be cured. The best parts to select are cuts where the lean and fat are firmly held together. Such cuts may be found in the loin, rump, sides, and the jowl. When a refrigerator is available any part of any size, such as the whole ham or shoulder may be cured.

When ice or a refrigerator is not used the pieces should not be more than one to one and a half kilogram in weight. If the meat can be cooled in a refrigerator before curing, but not during the process, it may be possible to cure pieces as large as two kilograms. When refrigeration is possible throughout the process, any size of pieces can be used.

Separate the pieces selected as soon as possible after scalding. Trim them so as to secure clean cut surfaces and borders and rounded angles. Each piece should be cut as uniform in thickness and width as possible. In cutting, avoid making ragged, lacerated, contused, or macerated cuts. To make a clean cut use a sharp knife, make few strokes, one, if possible. Do not saw.

COOLING THE MEAT

It is essential that no animal heat be in the meat when it is put into the curing solution (brine). Only thoroughly cooled meat will have a firm texture when cured. When not cooled to as low a temperature as 25° C. (77° F.), the cured meat may be good as to odor but the texture will be soft and pulpy and the fat will ooze out from the middle parts of the piece.

When a refrigerator or ice is not used let the meat cool from 6 to 8 hours during the coolest part of the day. Hang up the pieces so they do not touch under a shelter that does not transmit heat and where there is free circulation of air. Select the highest elevation possible. If a refrigerator is used the pieces need not be trimmed to their final form before cooling; this can be done just before putting them into the brine. Large pieces, as whole legs, should be cooled in the refrigerator for 12-24 hours, at least.

THE BRINE

The principal preservatives used are: (1) common salt as the basis; (2) saltpeter as preservative of the meat and also of the natural flesh color; (3) sugar to impart desirable flavor; and (4) water as solvent for the solid ingredients. Baking soda (sodium bicarbonate) may also be added to help keep the meat from souring. Other ingredients, such as black pepper, cinnamon, etc., may be added for seasoning.

These ingredients mixed together form the brine. The proportions are: For every 50 kilograms of meat when a refrigerator is not available:

(1) 12-16 kilograms of common salt.
(2) 2-3 kilograms of sugar (brown or white).
(3) 160-200 grams of saltpeter.
(4) 40-80 grams of baking soda (sodium bicarbonate).
(5) 56-60 liters of water.

Variations within the above amounts may be made according to taste. When a refrigerator is used, reduce the amount of the brine given above to one-half for the same amount of meat.

To make the brine, dissolve the solid ingredients in the water and boil. Strain off impurities and make up the water to the necessary amount by adding boiled water. Allow the brine to cool.

PACKING THE MEAT IN THE VESSEL

The following containers have been found to give satisfaction: (1) Chinese made earthen vessel *camao;* (2) Filipino made earthen pot *palayok,* with wide mouth; (3) tinaja *tapayan* when curing a large quantity; (4) any wooden container which does not impart an undesirable odor. Metallic vessels are undesirable because they corrode and spoil the color and flavor of the meat.

After the vessel has been thoroughly cleaned, scalded, and cooled, pack in it the pieces of meat with the flesh side up, except those that make up the top layer which should be laid with the skin side up. Pack in the large pieces first, then the small pieces. Put over the meat a weight (flat stones, plates, or pieces of hard wood) sufficient to prevent the pieces of meat from floating. A good plan is to place bamboo slats under the weight. Finally, pour over slowly and carefully the brine which should be as cool as possible. Every part of the meat must be kept well immersed at all times during the curing process.

During the process of curing keep the container in any cool, well ventilated place, when a refrigerator is not used. The most convenient place, perhaps, is where the water cooler is usually kept, or at the *banguera.* The meat may be kept at a still lower temperature than that of the surroundings by wrapping over the container pieces of cloth, burlap or gunny sack, and keeping them moist.

TIME IN BRINE

Allow from 6 to 8 days in brine for every kilogram of meat in a piece. For example, a two-kilogram piece of meat should remain in the brine for 12 to 16 days; a one-half-kilogram piece for 3 to 4 days. At the end of the required time take the meat out, preferably in the evening, and allow it to drain over night in any airy place, such as an open shelter or above the fireplace.

If the brine after the meat is taken out is clear and fresh and free from mold the meat need not be rinsed. But, if the brine has become ropy or moldy the meat should be rinsed in cool salted water before hanging it up to drain.

When the meat cures satisfactorily there is no need of repacking during the process of curing. Sometimes, however, it does not cure well and repacking becomes necessary. If about the second or third day after the meat has been packed in the vessel, bubbles come to the surface, the curing is not going on satisfactorily. Press the packed meat with the hand and if a rather disagreeable odor is noticed the meat should be overhauled and examined. In many cases only a part of a piece is affected, while the rest may be curing nicely. With as little handling as possible cut out the affected parts and rinse the rest of the meat. Repack in a clean vessel. Either use a freshly prepared brine or boil and cool the same brine before pouring it over the repacked meat.

SMOKING

Early the morning after taking the meat from the brine, begin to smoke it. The meat may be smoked both day and night, or over the *kalang* only when cooking of food is done. Smoking is continued until the skin or fat surface assumes an amber color which is obtained in about a week or ten days when smoked continuously, and in two to three weeks when smoked only at cooking times.

The meat should be hung up not lower than one and one-half meters above the fireplace and the pieces should not come in contact with each other.

Keep off the flies by smoking the meat inside a box; a petroleum box will do, suspended over the fireplace with the bottom closed with a piece of wire netting or a piece of *sinamay* mosquito netting.

Under average conditions, the best way to store cured meat is to hang the pieces up inside a well ventilated place.

THE RICE ROOT APHIS (DRYOPEIA HIRSUTA A. C. BAKER)[1]

By José P. Tan

The rice root-aphis (*Dryopeia hirsuta* A. C. Baker) was first noticed in Los Baños, Laguna Province, about six years ago, by C. F. Baker, Dean of the College of Agriculture. The insect has never been reported as causing serious injury. It is often associated with rice roots, especially of upland varieties, although no conspicuous damage to the plant has been noted.

No previous biological work has been done on this pest; in fact the only records of this species available are a systematic paper by A. C. Baker (1) wherein the insect is described as new, and a casual mention of its occurrence in Formosa by Takahashi (2, p. 152).

The object of the present work was to collect biological data on *Dryopeia*. The experiments were begun in April, 1922, and carried on from that time until the present writing, in February, 1924. The work was conducted largely in the rice fields of the College of Agriculture, Los Baños.

MATERIALS AND METHODS

Two methods of rearing the insects in captivity were found satisfactory: (a) In vials provided with cut roots. This method needed frequent attention; the roots had to be changed at least once a day. (b) Transplanting rice into glass-faced boxes. These boxes measured about 12″×7″×5″. On each lateral side a piece of glass was fitted by inserting it through a slot provided with grooves in the wooden frames. Young rice plants were then transplanted near enough the glass panes to allow easy observation of the roots. The latter were kept dark by covering the glass on the outside with removable tin sheets cut from petroleum cans. Aphids reared on the roots in this manner could be studied without unnecessarily disturbing the cultures.

EXPERIMENTS AND RESULTS

LIFE HISTORY

The work on life history was conducted in April and May, 1923. Full grown material was collected from the field and the nymphs born from this, isolated. Two series were used, and treated according to the methods described in the foregoing paragraphs: (a) Cultures 1 to 40, kept on cut rice roots in glass vials, designated as Series A. (b) Cultures 41 to 80, on growing rice roots in glass-faced cages, designated as Series B. Observations were made separately on the numbers of pre-adult molts; number and duration of nymphal instars; length of adult stage; total life cycle; and total longevity. Table I is an abridged summary from two long tables, representing data on Series A and B, which had to be omitted from publication on account of their size.

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[1] Thesis presented for graduation with the degree of Bachelor of Agriculture from the College of Agriculture, No. 194; Experiment Station contribution, No. 251. Prepared in the Department of Entomology under the direction of Assistant Professor L. B. Uichanco.

TABLE I.—*Life History of Dryopeia hirsuta. (Results from Series A and B compared).*

	Series A	Series B
	days	*days*
First instar:		
Maximum	4	3
Minimum	1	1
Average	2.5	2.2
Second instar:		
Maximum	4	4
Minimum	2	2
Average	3.15	2.77
Third instar:		
Maximum	6.0	5.0
Minimum	3.0	3.0
Average	4.07	3.75
Fourth instar:		
Maximum	6.0	7.0
Minimum	3.0	5.0
Average	4.9	5.6
Nymphal stage:		
Maximum	18.0	16.0
Minimum	12.0	13.0
Average	14.42	14.47
Life cycle:		
Maximum	18.0	16.0
Minimum	13.0	13.0
Average	14.95	14.67
Length of adult stage:		
Maximum	19.0	19.0
Minimum	10.0	12.0
Average	15.5	16.15
Total longevity:		
Maximum	34.0	34.0
Minimum	24.0	26.0
Average	29.95	30.82

It may be seen from an examination of Table I that there are invariably four post-embryonic molts, the fourth marking the transition to the adult stage. It may be seen from the table that there is no appreciable difference between the results obtained in Series A and those obtained in Series B, so that one experimental method checks up the other. The duration of each instar, total length of nymphal stage, total life cycle (from birth of mother to birth of first young from that mother), length of adult stage, and total longevity are given in easily accessible form in the table.

PARTURITION IN PARTHENOGENETIC DRYOPEIA HIRSUTA IN RELATION TO THE AGE OF THE MOTHER

The data on which the present observations are based were secured from the same material as those used in life history work, as given in Table I. The objects of the experiments were to determine the age at which the mother begins to give birth, length of the period of fecundity, total number of young produced by the mother during her entire life, number of days in which the mother continues to live after the end of her period of fecundity and interval between last molt and birth of first young. A summary of the results is given in Table II. This table is abridged from two tables which are too extensive for publication.

TABLE II.—*A comparative summary of parturition in parthenogenetic Dryopeia hirsuta, in relation to the age of the mother. (Data obtained from Series A and B).*

	Series A	Series B
	days	*days*
Age of mother at birth of first young:		
Minimum	13	13
Maximum	18	16
Average	14.7	14.6
Interval between last molt and birth of first young:		
Minimum	0	0
Maximum	1	2
Average	0.27	0.17
Period of fecundity:		
Minimum	9	12
Maximum	18	18
Average	14.15	14.6
Total number of young born:		
Minimum	23[a]	22[a]
Maximum	69	71
Average	36.47	43.07
Life of mother after period of fecundity:		
Minimum	0	0
Maximum	4	4
Average	1.15	1.1

[a] Number of young, not days.

Table II gives in number of days the minimum, maximum, and average ages of the mother at birth of first young; the interval between the last molt of mother to the birth of the first young from that mother, which shows the number of days elapsing from the time the insect becomes an adult until she begins to give birth; the period of fecundity; the number of days the mother survives after this period of fecundity; and the total number of young born. The results obtained in the two experimental methods used in Series A and Series B show no important differences.

Amphigonous forms (individuals which involve the union of reproductive cells of both sexes) of this particular insect were not found during the course of the present investigations. These aphids apparently reproduced exclusively by parthenogenesis, a condition which seems to obtain with all members of this group in tropical countries, as was pointed out by Uichanco (3) and by other authors.

RELATION OF ALATE TO APTEROUS PARTHENOGENETIC FORMS UNDER VARIOUS CONDITIONS

Host plants were collected at random in different parts of the College Farm and at different times. The plants were pulled up carefully, so as to avoid dislodging the aphids, and brought into the laboratory. The total number of indi-

viduals present in each plant and the number of alate forms in each lot were counted. The experiments were begun in April, 1923, and carried through to November of the same year, covering thus a period of eight months. The results of these experiments are given in Tables III and III-A.

TABLE III.—*Relation of alate to apterous parthenogenetic individuals under various conditions. (Observations from April to November, 1923; total, eight months.)*

Date.	Total number of aphids collected.	Total number of alate.	Percentage of alate.	Average monthly percentage of alate.
1923				
April 7	84	9	9.57	
" 8	99	4	4.04	
" 12	377	28	7.46	
" 14	106	18	8.73	
" 15	179	16	8.93	
" 17	396	51	12.87	
" 19	155	22	14.19	
" 21	339	36	10.61	
" 24	237	22	9.28	
" 26	224	22	9.90	
" 28	251	39	15.56	10.10
May 1	104	10	9.61	
" 3	235	32	13.61	
" 5	307	53	13.02	
" 17	297	34	11.41	
" 19	377	70	18.57	
" 21	302	59	19.53	
" 24	260	58	22.30	
" 26	134	24	19.40	
" 29	74	11	14.87	
" 31	529	114	21.55	16.38
June 9	179	3	1.67	
" 16	142	6	4.02	
" 22	128	3	2.34	
" 26	67	000	0.00	
" 30	83	1	1.20	1.84
July 7	123	5	4.06	
" 14	80	1	1.25	
" 19	121	000	0.00	
" 26	67	1	1.49	
" 31	130	3	2.30	1.82
Aug. 4	40	2	5.00	
" 11	75	2	2.66	
" 18	23	000	0.00	
" 25	43	1	2.32	
" 31	21	000	0.00	1.99
Sept. 8	67	4	5.97	
" 15	95	3	3.15	
" 19	135	4	2.96	
" 22	36	000	0.00	
" 29	126	3	2.38	2.89
Oct. 6	130	4	3.07	
" 13	131	000	0.00	
" 16	122	6	4.05	
" 20	135	4	2.96	
" 27	29	1	3.44	2.70
Nov. 3	65	2	3.07	
" 7	45	000	0.00	
" 13	93	4	4.30	
" 17	133	5	3.75	
" 24	93	1	1.07	2.43

TABLE III-A.—*Relation of alate to apterous parthenogenetic individuals under various conditions. (Observation from April to November, 1923; total eight months.)*

Date.		Percentage of alate.[a]	Temperature.[b]	Daily precipitation.
1923		*per cent.*	*°C.*	*mm.*
April	Maximum	15.56	31.2	3.5
	Minimum	4.04	22.8	0.0
	Average	10.19	27.0	0.26
May	Maximum	22.3	29.8	36.8
	Minimum	9.61	23.2	0.0
	Average	16.38	26.5	6.7
June	Maximum	4.02	28.6	140.0
	Minimum	0.00	24.0	0.0
	Average	1.84	26.18	11.8
July	Maximum	4.06	29.0	167.0
	Minimum	0.00	22.7	0.0
	Average	1.82	25.9	16.5
August	Maximum	5.00	28.2	117.9
	Minimum	0.00	23.3	0.0
	Average	1.99	25.8	16.9
September	Maximum	5.97	28.9	39.1
	Minimum	0.00	23.3	0.0
	Average	2.89	26.1	7.3
October	Maximum	4.05	28.5	46.0
	Minimum	0.00	23.0	0.0
	Average	2.7	25.8	4.34
November	Maximum	4.3	27.3	214.2
	Minimum	0.0	22.7	0.0
	Average	2.43	25.0	16.66

[a] Summary of percentages from Table III.

[b] Temperature and rainfall observations by Mr. Roman P. Estioko.

From study of Tables III and III-A it may be inferred that temperature and precipitation form important determining factors in the production of alate forms. As the temperature falls and precipitation increases, alate forms decrease in number in proportion to the apterous. High temperature and low precipitation, on the other hand, tend to increase the ratio. Thus from June to November, 1923, when the maximum temperature was 29° C. and the minimum, 22.7° C., and maximum daily precipitation, 214.2 millimeters, minimum, 0 millimeter, the highest percentage of alate forms was 5.97, as compared with 15.56 in April and May, when the maximum temperature was 31.2° C. and minimum, 22.8° C., and maximum daily precipitation 36.8 millimeters, minimum, 0 millimeter. It must be pointed out in this connection that in the period embracing the months from June to November, rainfall was more evenly distributed, thus raising the average up to 16.9 millimeters a day, whereas, during the rest of the time covered by the experiment precipitation seldom occurred and was scanty, the highest average being only 6.7 millimeters a day.

High temperature accompanied by extreme dryness resulting from scanty rainfall unquestionably brings about conditions unfavorable to the life of the aphid, as also to other animals. Production of alate forms is a response to this unfavorable condition. Uichanco (3) gives in his paper a discussion on the rôle of temperature. He cites Ewing's (4) observation wherein there was noted an optimum temperature of 65° F. (18.33° C.), which produced the lowest percentage of winged individuals in the aphid species with which he worked. Gregory (5), also cited by the same author, further showed that varying degrees of starvation proportionately increased the percentage of alate forms. Dryness and high temperature, among other effects, certainly diminished the food supply of the aphids in the present experiments.

NATURAL ENEMIES

During the period covered by the experiments herein reported no important natural enemy was met with. There was only an unidentified small species of spider which preyed upon the insects from time to time.

PROTECTORS

A small species of ants was found associated with *Dryopeia* in a large number of cases. When a plant on the roots of which the aphids are feeding is pulled up, the ants seize the aphids, especially the nymphs, and carry them away. The symbiotic relation between ants and aphids, in connection with numerous other species, has been known for a long time, whereby in exchange for the sweet substance which the latter excrete from the anus, the former protect them from enemies and even serve as agents in their dispersal. Wheeler (6, pp. 339-360) gives a convenient discussion of this phase of the subject. *Dryopeia* was observed in the present experiments to produce this sweet exudate whenever the ants stroked its body with their antennae.

FOOD PLANTS

During the time when rice is not growing, *Dryopeia hirsuta* subsists on wild grasses. Apparently the insect prefers rice to any of its other food plants and readily migrates to it whenever it is available. This condition is shown in Table IV, and in the discussion which follows, wherein it may be seen that abundance of the insect on rice is accompanied by a corresponding scarcity of the wild food plants.

A field survey on the College Farm on the dates given below resulted in the discovery of the following wild host plants of *Dryopeia*.

April, 1922. *Digitaria corymbosa* Roxb.[2] *Panicum colonum* Linn., and *Eleusine indica* (Linn.) Gaertn. These species of grasses covered an area of 250 square meters. The land had previously been planted to rice.

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[2] Identification of all the species of grasses used in the present experiments was made by Dr. E. Quisumbing of the Department of Plant Physiology of this College.

May, 1922. *Panicum reptans* Linn., and *Fimbrystilis miliacea* (Linn.) Vahl. There was no rice in the immediate vicinity. The land had not been previously planted to rice.

December, 1922. *Eragrostis interrupta* (R. Br.) Beauv. This grass was found near a rice field.

Abundance of Dryopeia on different grasses.—Experiment was conducted with six species of grasses commonly found in the rice fields of the College and vicinity. All of these grasses grow throughout the year and they undoubtedly furnish food to *Dryopeia* when rice is not growing. The object of the experiment was to determine the abundance of *Dryopeia* on the different grasses in various parts of the year and also the favorite hosts of the insect in a given time.

At irregular intervals during 1922-1923, counts were made in widely scattered localities. In each case the grasses were carefully pulled up and precautions were taken to prevent any of the aphids dropping off. Care was taken to make observations on grasses which were in head, so as to have as much uniformity as possible in comparative age. The results are shown in Table IV.

TABLE IV.—*Abundance of Dryopeia hirsuta on alternate host plants. (Observations from April, 1922, to March, 1923.)* [a]

Date.	Panicum reptans.	Fimbrystilis indica.	Eleusine indica.	Digitaria corymbosa.	Panicum colonum.	Eragrostis interrupta.
1922	Monthly average number of insects per plant.	Monthly average number of insects per plant.	Monthly average number of insects per plant.	Monthly average number of insects per plant.	Monthly average number of insects per plant.	Monthly average number of insects per plant.
April	14.75	21.0	17.7	37.2	63.5	60.7
May	23.80	27.7	24.4	34.2	59.7	59.8
June	14.7	13.0	13.2	19.2	36.4	32.7
July	10.5	7.5	3.7	10.7	13.7	16.7
August	7.6	4.6	6.0	9.6	10.0	10.0
September	4.5	8.2	10.0	10.0	11.2	11.7
October	7.25	11.2	7.0	8.5	11.2	9.2
November	11.5	16.2	10.5	13.7	16.0	15.7
December	14.5	12.75	14.25	15.5	20.5	19.2
1923						
January	18.7	19.0	13.7	24.0	26.7	29.7
February	29.2	23.75	23.7	30.5	33.2	40.0
March	27.75	32.0	31.5	31.5	45.7	54.5
General averages	15.37	16.32	12.13	20.38	29.81	30.82

[a] This table is abridged from a more detailed one which has been withdrawn from publication on account of its length.

According to the data in Table IV *Dryopeia* was observed to be present from April, 1922, to March, 1923, in the six species of grasses. It was more abundant during the period covering the months of January, February, March, April and May than during the period from June to December; the highest average number to a plant in the first five months period being 63.5, as compared with 36.4 in the remaining seven months of the year. Rice is grown in abundance in this

locality from June to December, and this scarcity of the aphids on the wild grasses is accompanied by a corresponding abundance of the insect on the roots of the rice. On the other hand, during the months of January, February, March, April, and May, when no rice is grown, aphids are more abundant on the wild grasses.

Digitaria corymbosa, *Panicum colonum*, and *Eragrostis interrupta* seemed to be the favorite wild host plants of *Dryopeia*. The highest average number of individuals found on these grasses were as follows: *Digitaria corymbosa*, 20.38; *Panicum colonum*, 29.81; and *Eragrostis interrupta*, 30.82; *Panicum reptans*, 15.37; *Fimbrystilis indica*, 16.32; and *Eleusine indica*, 12.13. The present experiments, however, were not conducted on a sufficiently extensive scale to establish definitely the preference or lack of preference for any particular host. This phase of the subject needs a more thorough investigation.

RELATION OF THE INSECT TO RICE

Nature and effect of infestation.—In many cases this aphid is sheltered in an irregular cavity with fairly smooth walls which look as if they had been purposely prepared for the accommodation of the insects. The cavity surrounds succulent rice roots. It measures about 1.5 centimeters in diameter. The ants mentioned above may have something to do with its formation.

The extent of damage done by *Dryopeia hirsuta* on the rice plant has not been observed under our conditions to be very great. Only rarely has this aphid been noted to cause stunting of the plant, the probable reason being that the insect does not commence its serious attack until after the plants are about one month old, when the host is sufficiently full grown to withstand injury resulting from feeding.

Susceptibility of different rice varieties.—Ten varieties of rice were used in this experiment; namely, Tiniaong, Kinandang pula, Maliro, Putyucanon, Kinastila, Calibo, Inantipolo, Binicol, Maglambas, and Inintiw. A paddy with an area of about 270 square meters, near the U. P. Sugar Mill, was used. The extent of damage on each variety was determined in the following manner: The paddy was planted in rows, each row being alloted to one variety. At maturity, the plants were pulled up and a record was made of the total number of plants in each row; the total number of plants infested in each row; and the weight of their yield.

The methods used in computing the data, as given in Table V, were: (a) Percentage of plants damaged—dividing the number of plants infested by the total number of plants in a particular lot and multiplying the quotient by one hundred. (b) Average yield per uninfested plant—by dividing the total yield of the uninfested plants by the total number of plants which produced it. (c) Average yield per infested plant—the same as in (b), using infested plants, instead. (d) Loss in yield in 100 plants as a result of infestation—by subtracting the yield of 100 infested plants from the yield of 100 uninfested. Disturbing factors which would affect the accuracy of conclusions drawn from the present experiments were considered. *Leptocorisa acuta* Thunberg was found to be present, but not in sufficiently large numbers to affect the results. Moreover, the plants were subjected to more or less the same conditions, so that the presence of pests, like this one, can be neglected for the purpose of the present computations. The results of these experiments are given in Table V.

TABLE V.—*Relative extent of damage on ten varieties of rice in the College of Agriculture.*

Row number.	Variety name.	College number.	Origin of variety.	Total number of plants.	Total number of plants infested.	Percentage of plants damaged.	Total yield of uninfested plants.	Total yield of infested plants.	Average yield per uninfested plant.	Average yield per infested plant.	Computed yield of 100 uninfested plants.	Computed yield of 100 infested plants.	Computed loss in yield of 100 plants.
							gm.	*gm.*	*gm.*	*gm.*	*gm.*	*gm.*	*gm.*
1	Tiniaong.....	9118	Santo Tomás, Batangas	1581	33	2.08	3293	61	2.177	1.800	217.7	180.0	37.7
2	Kinandang pula	9094	Santo Tomás, Batangas	1578	30	1.90	3140	59	2.028	1.966	202.8	196.6	6.2[a]
3	Maliro.....	4491	Bureau of Agriculture..	1548	61	3.94	2545	107	1.704	1.754	170.4	175.4	(+5.0)
4	Putyucanon....	4497	Bureau of Agriculture..	1590	49	3.08	2944	93	1.910	1.897	191.0	189.7	1.3
5	Kinastila.....	4495	Bureau of Agriculture..	1467	47	3.20	2450	73	1.725	1.553	172.5	155.3	17.2
6	Calibo.....	11,531	Mariveles, Bataan.....	1406	101	7.18	1989	119	1.524	1.178	152.4	117.8	34.6
7	Inantipolo.....	9217	Santo Tomás, Batangas	1525	74	4.90	2429	97	1.674	1.310	167.4	131.0	36.4
8	Binicol.....	4478	Bureau of Agriculture..	1571	53	3.37	3137	92	2.066	1.735	206.6	173.5	23.1
9	Naglambas....	9090	Taal, Batangas.....	1554	72	4.63	2256	82	1.532	1.137	153.2	113.7	39.5
10	Inintiw.....	3052	Maajas, Los Baños....	1538	39	2.53	2694	73	2.079	1.878	207.9	187.8	20.1

[a] Increase in yield of the infested plants over the uninfested ones.

An examination of Table V tends to show that varying degrees of susceptibility are exhibited by different rice varieties. Variety Kinandang pula, with only 1.9 per cent of infestation, seems to be least preferred by the insect, while Calibo, with 7.18 per cent, showed the highest percentage of plants attacked. The loss in yield resulting from the attack of the insects appears to be greatest in Naglambas, wherein the computed diminution in yield for every 100 plants was 39.5 grams, while the least was in Putyucanon, with a loss of only 1.3 grams. It may be seen, therefore, from the foregoing data that the degree of infestation by the aphid is not necessarily accompanied by a corresponding lowering of yield, for, otherwise, Calibo would have given the least yield, and Kinandang pula the greatest among the varieties studied. In fact, Maliro in which 3.94 per cent of the plants were damaged, even showed an increase in yield over the uninfested plants. These conditions point to the fact that (a) certain varieties of rice are more readily attacked than others; and (b) that different varieties have different reactions to the attack of the root aphid, so that while the yield in some is markedly affected, others do not seem to suffer.

Relation of occurrence to age of rice.—Experiments were performed on one rice variety, Naglambas, to determine the age at which rice is most susceptible to the attack of *Dryopeia*. The first lot was planted on June 15, 1923; every ten days thereafter another lot was planted. The experiments were closed on October 3, 1923, when the first lot began to flower. On this date there were eleven lots in different age gradations from 110 days down to 10 days. All plants in each lot were pulled up and the plants which were infested and those which were not, noted. Results of these experiments are shown in Table VI.

TABLE VI.—*Relation of occurrence of Dryopeia to age of rice. (Observations made on October 3, 1923.)*

Age of plants.	Total number of plants in a row.	Total number of plants infested.	Percentage of infestation.
days			
10	165	5	3.03
20	155	9	5.71
30	170	16	9.41
40	165	28	23.00
50	160	26	15.21
60	168	20	11.9
70	163	19	11.6
80	165	10	6.06
90	173	9	5.14
100	170	7	4.11
110	172	6	3.48

From Table VI we note the following results:

1. Rice was least heavily infested (3.1 per cent of infestation) when the plants were about 10 days old.

2. The degree of infestation began to be markedly accelerated from the time the plants attained an age of 30 days (9.4 per cent).

3. Infestation reached its maximum degree when the rice was about 40 days old (23 per cent).

4. From the time the plants were 40 days old infestation began to decrease gradually until by the time the rice reached an age of 110 days, at flowering, the attack of the aphid again reached the low ebb of 3.5 per cent.

SUMMARY AND CONCLUSIONS

1. *Dryopeia hirsuta* A. C. Baker is not very well known in the Philippines. It has never been reported as causing serious injury.

2. The insect has been reported in other countries, as in Tainan, Formosa.

3. It is found associated with the roots of upland rice and certain other grasses.

4. Two methods of rearing the insects in captivity were found satisfactory: (a) In vials provided with cut roots; (b) transplanting rice into glass-faced boxes.

5. During the course of the present investigations, the aphids were found to be exclusively parthenogenetic. No amphigonous forms were discovered.

6. The life cycle of the aphid (from birth of mother to birth of first young from that mother) was observed in the laboratory to range from 13 to 18 days.

7. Total longevity (from birth to death) was from 24 to 34 days.

8. The aphid began to produce young immediately or one day after the adult stage.

9. The period of fecundity of the insect was found in the laboratory to range from 9 to 18 days, the average being 14.15 days.

10. The mother survived her period of fecundity by at most 4 days.

11. The total number of young produced by one mother during her entire life ranged from 23 to 69, the average being 364.

12. The nymph molted four times before reaching the adult stage.

13. The total length of nymphal stage ranged from 12 to 18 days; first instar, from 1 to 4 days; second instar, from 2 to 4 days; third instar, from 3 to 6 days, and fourth instar from 3 to 6 days; adult stage 10 to 19 days.

14. Alate forms were found more numerous during April and May, the highest percentage being 15.36, than in the period from June to November when the maximum was only 5.97 per cent.

15. The increase in the number of alate forms in proportion to the apterous is shown in the present work to be apparently a response to unfavorable climatic conditions, such as dryness and high temperature, together with the consequent scarcity of food.

16. No important natural enemies were found during the course of the present investigations.

17. The aphid was observed to be protected by a species of ant, its relation being symbiotic, a condition well known to exist between these two groups of insects.

18. Wild grasses, such as *Digitaria corymbosa*, *Panicum colonum*, *Eleusine indica*, *Panicum reptans*, *Fimbrystilis miliacea*, and *Eragrostis interrupta*, serve as wild hosts for *Dryopeia*.

19. The insect seems to prefer rice to the wild grasses. This aphid was relatively scarce on the roots of the latter during the rice-growing seasons.

20. Certain varieties of rice appeared to be preferred by *Dryopeia* to others.

21. Increase in the degree of infestation by *Dryopeia* was not necessarily followed by decrease in yield of grains.

22. Rice, at least of the variety Naglambas, under Los Baños conditions, begins to become mildly infested when it is about ten days old; infestation reaches its maximum degree when the rice is about forty days old, and from that time on gradually decreases, reaching the low level at about the time of flowering.

RECOMMENDATIONS

The pest is not sufficiently injurious to warrant employment of control measures which are especially directed against it. In case it should become troublesome, however, the following measures are recommended: Clean culture of the fields, before and after rice planting; thorough removal of wild grasses which serve as wild hosts; encouragement of parasites and predators; planting of resistant varieties.

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THE EFFECT OF DISTANCING ON TOBACCO LEAF[1]

By Severino B. Imatong

WITH FIVE TEXT FIGURES

INTRODUCTION

The effects of distancing on tobacco leaf is one of the most important problems in the tobacco industry and one to which tobacco growers in the Philippines have paid little or no attention. They do not have standard distancing in setting their tobacco plants. Many contend that close planting gives a greater yield because more plants are planted in a given area. Other growers recognize that close planting affects the quality and size of the leaves produced as they are small thin fine leaves. If the plants be planted far apart, the leaves will be large and coarse in texture. Because close planting checks the rapid growth of weeds in the field and reduces the need of cultivation, it is frequently recommended for wrapper tobacco. But close planting increases the difficulty in harvesting the leaves. Wide planting is preferred for growing coarse tobacco; while there is greater space for weed growth, more animal power can be used. Many tobacco farmers set their plants far apart, so they will produce thick leaves. It is their belief that such leaves give more returns than thin ones. This belief is especially prevalent in Pangasinan.

The question may be asked: What is the right distance for planting tobacco to secure the maximum yield and best quality of tobacco leaf? This question is rather hard to answer. There are several factors to be taken into consideration, such as the climatic conditions, soil fertility, variety of tobacco planted, kind of product desired.

Very little systematic attempt to study the effects of distancing on tobacco leaf has been made in other countries, and no claim is made that the study here reported can be a guide to tobacco growers in the Philippines for distancing. There are many factors that enter into the effects of distancing on the quality of tobacco leaf produced; hence the subject requires investigation covering a number of years. The investigations reported here are limited and the results must be considered as suggestive rather than as conclusive. It is hoped that the experience gained within the limits of the experiment will be of use to other tobacco workers.

PREVIOUS INVESTIGATION ON THE SUBJECT

So far as available literature indicates, no investigation on the effect of distancing upon the tobacco leaf has ever been carried out in the Philippines. Most of the work done in the Islands has been on cultural methods, fertilization, hybridization, selection, curing, and fermentation.

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[1] Thesis presented for graduation from the College of Agriculture with the degree of Bachelor of Agriculture, No. 195; Experiment Station contribution, No. 252. Prepared in the Department of Agronomy under the supervision of Mr. Pedro A. David and Professor J. E. Higgins.

Frear, Olson, Kraybill, and Erb (1) made investigations at the Pennsylvania Experiment Station on spacing and topping. In the experiment they employed the following:

	Normal spacings.	*Close spacings.*
Broadleaf.....	28 by 42 inches	28 by 36 inches
Havana.....	14 by 42 inches	14 by 36 inches

	Top High.	*Top low.*
Broadleaf.....	16 leaves	12 leaves
Havana.....	18 leaves	14 leaves

Their results follow:

Types of tobacco.	Normal space.		Close space.	
	Top high.	Top low.	Top high.	Top low.
	lbs.	*lbs.*	*lbs.*	*lbs.*
Broadleaf.....	1,885	1,678	1,693	1,713
Havana.....	1,125	1,150	1,585	1,301
All.....	1,505	1,414	1,639	1,507

From these results it may be seen that Broadleaf gave the highest yield when topped high and planted 28 by 42 inches. The least yield was obtained when the plants were topped low under the same distance of planting. Havana gave the highest yield when planted 14 by 36 inches and topped high. The lowest yield was obtained when the plants were planted 28 by 42 inches and topped high. Taking the average of the two, close spacing gave higher yield than normal spacing.

Another experiment on the best distance for planting tobacco using Zimmer Spanish was conducted at the Ohio Agricultural Experiment Station at Wooster, Ohio, with the results here given. The distance between the rows was 34 inches (2).

Spacing of plants in the row.	Yield (pounds per acre)				Total value per acre.
	Trash.	Filler.	Wrapper.	Total.	
16 inches.....	172	193	1,065	1,430	$128.38
20 inches.....	156	169	995	1,320	118.74
24 inches.....	143	156	963	1,252	114.05
28 inches.....	140	136	900	1,176	105.70
32 inches.....	120	151	833	1,104	100.20
36 inches.....	119	146	836	1,101	99.99
40 inches.....	107	122	790	1,019	92.81

The tabulation given above shows a steady increase in yield from the widest planting of 40 inches to the closest planting of 16 inches. In regard to quality, the plants set 16 by 34 inches were rather flimsy, probably due to immaturity. According to Selby and Houser (2) distances slightly farther apart than 16 by 34 inches gave the best result, both in yield and in quality of products produced. Both men contend that close planting seemed very strongly to repress the growth of suckers, especially on the lower parts of the plant where they are most difficult to remove.

In order to know the best distance of planting, it is advisable and desirable to carry similar experiments for a number of years on various types of soil and

with several varieties of tobacco that are commonly grown in the Philippine Islands. After such a series of experiments, it may be possible to make recommendations as to the best distances for planting the different varieties of tobacco.

OBJECTS OF THE PRESENT WORK

To study the effects of distancing on: (a) Total height of the tobacco plants; (b) Size of the leaves; (c) Weight of sand, standard, and top leaves; (d) Quality of cured and fermented leaves.

TIME AND PLACE OF THE PRESENT WORK

This work was begun August, 1921, and closed October, 1922. The cultures were conducted in the Experiment Station grounds, College of Agriculture, Los Baños.

MATERIALS AND PLAN OF THE WORK

THE LAND

The land used for this work is located north of the Animal Husbandry Building. The surface soil is a clay loam of a depth of 15 to 30 centimeters subtended by tuff. It was previously planted to rice followed by velvet beans. The land is suitable for planting tobacco. It was well leveled and drained.

VARIETIES OF TOBACCO USED

There were four different varieties of commercial tobacco used in this investigation. They were three native varieties, San Juan Batec, College Number 17227; Pampano, College Number 5872; and Dammao Broadleaf, College Number 9975; and a foreign variety, Florida Sumatra, College Number 388.

Description of the varieties used

A. San Juan Batec, College Number 17227
   1. Height, 125 centimeters
   2. Size of leaves, 20.2 by 42.9 centimeters
   3. Texture, gummy
   4. Color of matured leaves, dark green
   5. Surface of leaves, smooth and wavy
   6. Position of leaves, drooping
   7. Average length of internodes, 2.6 centimeters

B. Pampano, College Number 5872
   1. Height, 105 centimeters
   2. Size of leaves, 15.9 by 37.2 centimeters
   3. Texture, gummy
   4. Color of matured leaves, light green
   5. Surface of leaves, smooth
   6. Position of leaves, horizontal
   7. Average length of internode, 2.4 centimeters

C. Dammao Broadleaf, College Number 9975
   1. Height, 102.5 centimeters
   2. Size of leaves, 15.9 by 36.4 centimeters
   3. Texture, gummy
   4. Color of matured leaves, light green
   5. Surface of leaves, hairy
   6. Position of leaves, horizontal
   7. Average length of internodes, 2.8 centimeters

D. Florida Sumatra, College Number 388
   1. Height, 112.6 centimeters
   2. Size of leaves, 13.1 by 38.1 centimeters
   3. Texture, pubescence
   4. Color of matured leaves, light green
   5. Surface of leaves, hairy
   6. Position of leaves, erect
   7. Average length of internodes, 2.6 centimeters

PLAN OF THE WORK

A suitable location was selected in August, 1921, and the seed beds prepared. The field in which the seed beds were located is situated near the coffee nursery of the College of Agriculture. In general, the nature of the soil is clay loam. The land is high enough to furnish good drainage. It was cleared and spaded several times. Four beds were made, each one meter by four meters. Each bed was surrounded with bamboo walls. These walls were 61 centimeters high in front and in the rear, 30.5 centimeters. The operation of tilling and stirring the soil preceded the sowing of the seed by several weeks. All roots, sticks, and other coarse materials were removed with rake and by hand. The soil was carefully pulverized after digging it several times to a depth of 30.5 centimeters.

A shelter made of cogon was constructed for each bed. This shelter was raised above the ground about 91.5 centimeters in front and 30.5 centimeters at the back. The soil in the seed bed was sterilized in the following manner. A part of the soil from the seed bed was put into a pan of galvanized iron roofing which was placed upon supports and heated for about two hours. Then the soil was returned to the seed bed. The seeds mixed with powdered napthaline were broadcasted on the seed bed in October, 1921. After the broadcasting, the surface of the bed was compacted with a piece of board and watered by spraying, then covered with the cogon shelter.

During the experiment, the soil was carefully watered early in the morning and late in the afternoon. In spraying the water, care was taken that there was not too much force, otherwise the seeds might be driven into the ground.

When the leaves of the seedlings were about the size of a ten-centavo piece they were pricked out and set at about 2.5 centimeters each way. Absolute control of the weeds was practised during the progress of the experiment. After the young plants were all well up, the cogon shelters were opened for a short time each day. The time of exposure was gradually increased. A few days before transplanting to the field, the shelter was removed and the plants exposed throughout the day to accustom the seedlings to the strong rays of the sun.

The preparation of the field was begun about the middle of December, 1921. The ground was first plowed and harrowed, using a tractor. After an interval of a week the operation was repeated. Animal power was used for the third plowing, followed by harrowing with tractor. These operations put the field in excellent physical condition.

The field was carefully laid out. There were forty plots ten by twenty meters side by side, separated by a space one meter wide. Each plot was divided into rows and hills.

The transplanting of the young seedlings was begun December 28, 1921, and finished January 8, 1922. Care was taken to plant only healthy and uniform seedlings. The work was done only in the morning and late in the afternoon.

The newly planted seedlings were watered every day and shaded with banana sheaths during the hotter part of the day. The seedlings in all the plots were cultivated in exactly the same way.

The number of plots, distances of planting, and the exact number of plants planted in each plot follow:

Plot No.	Distances.		No. of plants in each plot.
	Row.	Hill.	
	cm.	*cm.*	
1	40	40	1,326
2	40	50	1,071
3	50	50	861
4	50	75	574
5	75	75	378
6	75	100	297
7	100	100	231
8	100	125	189
9	125	125	153
10	125	150	119

One hundred plants in each plot were measured weekly. Forty days after transplanting, measurement was begun and continued up to the maturity of the plants. The weekly measurements were made the same day for all the plots.

Measurements of the length and width of one hundred sand, one hundred standard, and one hundred top leaves from each variety in each plot were made.

Care was taken to keep the plots in good tilth. The ground was cultivated with a garden hoe several times during the progress of this experiment, all plants being given the same cultivation. Suckering was done after the last cultivation. The removal of suckers which appear at the axils of the leaves is very important, as they are great consumers of the nourishment of the plant. For this reason, they should be removed regularly.

Harvesting of the leaves was done by priming, or the gathering of the leaves singly from the stalk as they reached the proper degree of ripeness. It is rather hard to make a definite set of rules as to when the leaves are ready to be harvested. Of course it is easy to distinguish between a green leaf and that which is too ripe, but priming requires accuracy of judgment which depends largely upon long practice and experience. Among the visible indications of ripeness is a yellowish color around the edges of leaves, especially at the tip, and sometimes spots in certain places of the leaf surface. The sand leaves were harvested first, then the standard, and finally the top leaves. The leaves were placed along the rows during priming and later gathered into round baskets and taken to the curing house. Priming was always done in the middle of the day. The fresh weight of the leaves from each plot was recorded. The leaves were allowed to wilt, and poled on the following day. Poling was done in the following manner: A pointed bamboo stick commonly called a *palillo* was run through the petioles of the leaves. The leaves were spaced about one centimeter apart. A *palillo*, about one meter long, accommodates from forty to one hundred leaves, depending upon the size. The freshly poled leaves were placed in the higher racks so that they could be more freely ventilated. The leaves that were nearly cured were placed on the lower racks until the completion of the curing process. The leaves were never exposed to the direct rays of the sun.

The management of the tobacco curing shed depended on the weather conditions. The precautions taken to secure the curing of the leaves were the closing of the windows and doors during very hot and dry days and also when a strong breeze blew. Damp days were found unfavorable for curing. The time for removing the leaves from the poles was when the midribs were also cured. After taking off the cured leaves they were weighed, then put into a wooden case for fermentation.

EXPERIMENTS AND RESULTS

In the study of the effect of distancing on the total height of the tobacco plant one hundred individuals in each plot were measured weekly. Beginning forty days from the date of transplanting, measurements were made until maturity of the plant. One hundred plants selected at random in each plot were marked by means of Dennison tags. With a meter stick, each plant was measured from the base mark on the ground to the highest point, which, in the tobacco plant is the highest capsule.

The summary of results of the measurements are represented in Figure 1.[2]

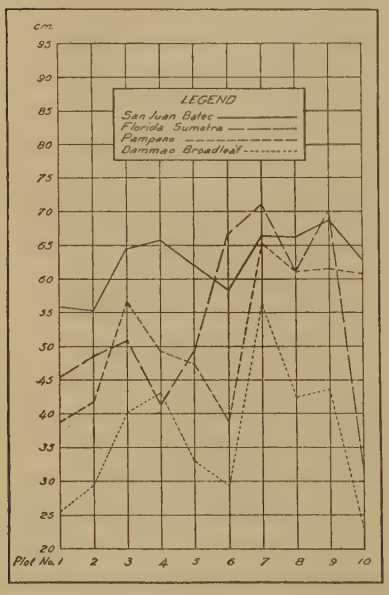

Fig. 1. Showing the summary of the average height of plants measured in each plot.

The effect of distancing on the size of the leaves was also studied. The greatest length and width of one hundred sand, standard, and top leaves from each plot were measured. The product of the length by the width of the leaf was the criterion used in comparing the size of the leaves produced in each plot. The measurements were made during the harvest time.

The summary of the measurements of the length by the width of one hundred sand, standard, and top leaves in each plot is represented in Figures 2 and 3.

In the study of the effect of distancing on the weight of sand, standard, and top leaves from each plot, these three types of leaves were harvested and weighed separately. One or two bottom leaves were discarded. The sand leaves were then counted. They varied in number from three to five. Then from about the fifth leaf, depending upon the age of the plant, the standard leaves were harvested. The last standard leaf was not less than thirty centimeters in length. All leaves distinctly less than thirty centimeters in length were counted as top leaves.

In studying the burning quality of the different leaves from each plot, the following method was used. A standard leaf from each plot was ignited by means of a lighted cigarette, and the number of seconds during which the glow produced continued was noted. The average of one hundred tests was used as measure

[2] Complete data of measurements have been filed with the Agronomy Department in tables that are too long for presentation here.

of the capacity of the leaves for holding fire. The area of the leaves burned was measured by means of a planimeter. The test was conducted in a close room, with wind which might affect the burning of the tobacco leaf shut out.

DISCUSSION OF RESULTS

The data shown in Figure 1 indicate plainly which of the four varieties of tobacco studied preferred a given distance for each maximum development in height. The variety San Juan Batec made its greatest growth at 125 by 125 centimeters, its least at 40 by 50. The most probable reason San Juan Batec had its greatest growth at wide distancing is that, as a variety, it is large and strongly vegetative. Florida Sumatra attained its greatest height when planted at 100 by 100 centimeters, and its least at 125 by 150. It is interesting to note that increasing the distance between the plants beyond a certain limit resulted in reduced growth in height. Varieties, Pampano and Dammao Broadleaf, made their greatest total height when planted at 100 by 100 centimeters, but the former made its least total height at 40 by 40 centimeters and the latter at 125 by 150. In the case of Dammao Broadleaf, the greatest growth in height was not made with the greatest available space.

As shown in Figures 2 and 3, different distances had different effects on the

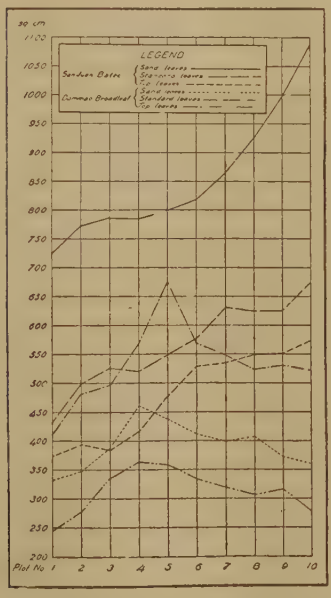

Fig. 2. Showing the average mean product of length by the width of one hundred sand, standard, and top leaves (San Juan Batec and Dammao Broadleaf) in each plot.

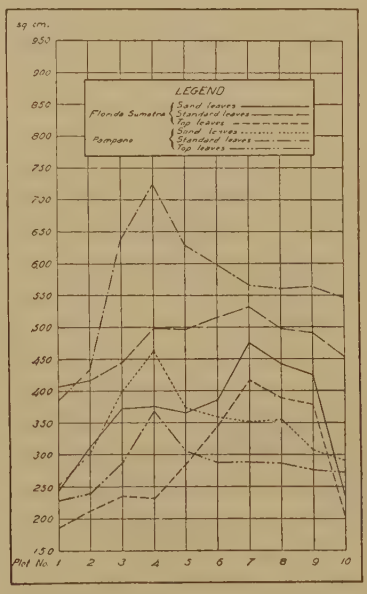

Fig. 3. Showing the average mean product of length by the width of one hundred sand, standard, and top leaves (Florida Sumatra and Pampano) in each plot.

size of leaves of the four varieties of tobacco studied. The sand, standard, and top leaves of San Juan Batec showed the greatest average size of leaf as measured by the product of their length by width when planted at 125 by 150 centimeters. The smallest leaves so measured were found in Plot No. 1 where the plants stood very close to each other. This small size of the leaves in Plot No. 1 may have been due to the limited space for their proper development. The largest leaves

were obtained from Plot No. 10 (125 by 150 centimeters), where the plants stood at the greatest distances. In this plot the leaves of plants had enough space for proper development. A few plants utilized the soil fertility. All of the varieties studied showed small leaves when planted at 40 by 40 centimeters. These small leaves may have been caused by the plants being so crowded that they had to struggle for the plant food in the soil and by their being limited in room for the leaves to expand and get sunlight. Florida Sumatra produced its largest sand, standard, and top leaves in Plot No. 7 (100 by 100 centimeters). Pampano produced its largest sand, standard, and top leaves in Plot No. 4 (50 by 75 centimeters). Dammao Broadleaf produced its largest sand and top leaves in Plot No. 4 (50 by 75 centimeters), while its standard leaves were produced in Plot No. 5 (75 by 75 centimeters). The smallest sand, standard, and top leaves of the varieties studied were produced in Plots No. 1 and 10 as shown in Figures 2 and 3.

Figure 4 shows the total of green and dry weight of sand, standard, and top leaves of the four varieties of tobacco plants planted at different distances. The results shown in this figure clearly indicate that in all of the varieties studied greater yields were obtained from close plantings. The logical explanation for this is that more plants were planted in a given area when planted closely than when planted farther apart.

Figure 5 shows the summary of the test on the burning quality of the standard

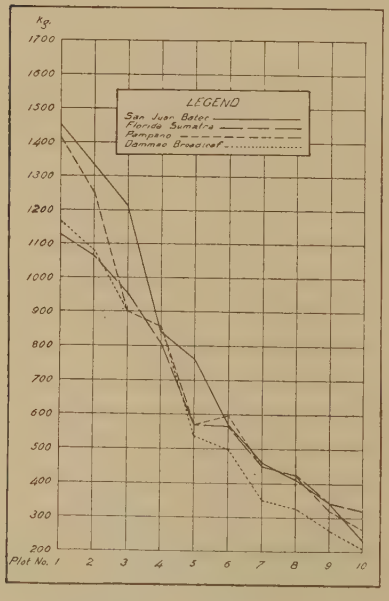

Fig. 4. Showing the summary of the total dry weight of sand, standard, and top leaves per hectare at different distances.

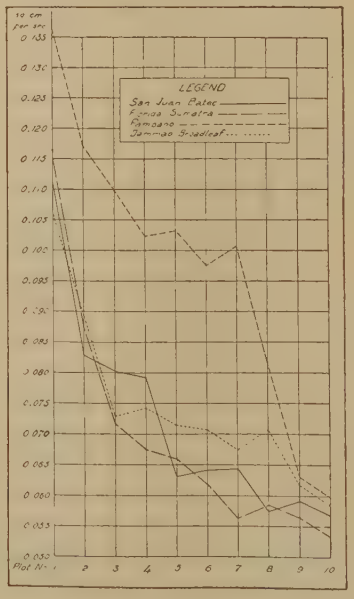

Fig. 5. Showing the summary of the tests on the burning quality of the standard leaves from different plots.

leaves from different plots. From these results, Plot No. 1 (40 by 40 centimeters) gave better burning quality than any other plot. Leaves of San Juan Batec obtained from close planting (Plot No. 1) had an area burnt per second of 0.1109 square centimeter. The areas burned per second from the same plot of Florida

Sumatra, Pampano and Dammao Broadleaf were 0.1149, 0.1364 and 0.1659 square centimeter, respectively. On wide planting in Plot No. 10, where 125 by 150 centimeters was used, the burning of the leaves was very slow, being 0.0567 square centimeter for San Juan Batec; 0.0533 square centimeter for Florida Sumatra; 0.0598 square centimeter for Pampano; and 0.0584 square centimeter for Dammao Broadleaf. Of the four varieties studied the leaves of Pampano burned most rapidly. The most probable reason for the leaves produced from close planting burning quickly is, that the leaves so obtained were rather thin and had small veins and the midribs were not well developed. Furthermore, gummy substance was little in comparison with that on leaves from wide distancing. Naturally in close planting, the leaves produced were thin, with little gummy substance, because they shaded and crowded each other. It is a well known fact that leaves under the shade are pale green, thin, and the veins are not well developed. On the other hand, the leaves produced from wide distancing were large, having well developed veins and midribs. The leaves were somewhat gummy in texture. It may be seen that burning quality of the leaves was better in close planting than in wide distancing. In Plot No. 10, the leaves from the four varieties used showed very poor burning quality.

SUMMARY OF CONCLUSIONS

From the data at hand the following conclusions appear to be indicated:

1. The different varieties of tobacco studied seemed to require different distancing.

2. The height of the tobacco plant is affected by the distance of planting but maximum spacing does not always produce maximum height.

3. The size of the leaves of tobacco is affected by the distance of planting. In general when tobacco is planted as close as 40 by 40 centimeters and 40 by 50 centimeters, it tends to produce many small leaves, but when spaced from 50 by 75 centimeters to 100 by 100 centimeters, it tends to gain in size of leaf.

4. The greatest calculated weight in kilograms of sand, standard, and top leaves per hectare was obtained from close planting, although the size of leaves obtained in close planting was very much reduced.

5. The burning quality of the leaves produced in close planting was generally improved. This may be due to the fact that the leaves from such planting were rather thin, small veined, and had undeveloped midribs and little of the gummy substance in them. The poor burning quality of the leaves produced from wide planting may be due to the coarse well developed veins and midribs and somewhat gummy texture of the leaves.

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THE EFFECT OF MANGANESE COMPOUNDS ON THE GROWTH AND YIELD OF RICE AS SHOWN BY POT CULTURES[1]

By Alejo L. Jimenez

In the study of the relation of manganese to agriculture, one is impressed with the lack of agreement in the results and conclusions of various investigators. While some maintain that manganese is an essential constituent of plants, others believe that it is only a stimulant.

Brenchley (1), after extended researches on the effect and function of manganese in the vegetable economy, arrived at the interesting conclusion that manganese, although occurring in very small quantities, is apparently not to be replaced by any other element.

The great majority of the investigators, on the other hand, are of the belief that plants can be grown in the absence of manganese. They are of the opinion that salts of manganese, in suitable dilution, stimulate growth and hence perform an important function in the development of plants. McHargue (2) gives an interesting account of this stimulating action. Roxas (3) used manganese sulfate ($MnSO_4$) as a fertilizer. He found that of all concentrations M1/1,000 gave the best result; also that concentrations of 1/10 and 1/50 of this value were without effect. A concentration of M1/1,000 manganese sulfate equals 0.151 gram $MnSO_4$, or 0.055 gram Mn per kilogram of soil, or 0.0055 per cent. It should be noted that Roxas did not determine the percentage of manganese in his soil and that the amounts used by him were very much less than those used by the writer.

Wilcox and Kelley (4) show that pineapples can be grown only with difficulty in highly manganiferous soils. Funchness (5) believes that the statement that the toxicity of certain plots on the Alabama Agricultural Experiment Station farm is to be ascribed to the presence of soluble manganese is untenable. Pfeiffer et al. (6) from results obtained on oat cultures held that manganese was practically inactive. Söderbaum (7), giving an account of ten experiments on manganese salts, reports at the end of ten years that only manganese carbonate plus alum gave a positive result. He further states that "for the present, the use of stimulating substances for agricultural practice is not justified".

The reports of these investigators, and of Johnson (8), Kelley (9), Carr and Brewer (10), and many others, led the writer to make a preliminary study of the effect of manganese compounds in different concentrations on plant growth; and the effect of lime on the action of these manganese salts. Rice was used in the experiments principally because of the importance of this crop in the Philippines.

MATERIALS AND METHODS

The rice was grown in paraffined kerosene cans with a known weight of soil, which was taken from a grassy field. The soil contained, under field conditions,

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[1] Thesis presented for graduation with the degree of Bachelor of Agriculture from the College of Agriculture No. 196; Experiment Station contribution No. 253. Prepared in the Department of Agricultural Chemistry, under the direction of Prof. F. W. Ashton.

12 per cent moisture, but when air-dry this was reduced to 6.4 per cent. In texture the soil is a clay loam, of dark brown to brown color. It is a residual soil from volcanic tuff. It showed by analysis 0.11 per cent manganese (Mn), 10.0 per cent iron (Fe), and a lime requirement of 3,120 kilograms per hectare—20 centimeters (one hectare in area, 20 cm. deep).

Three concentrations were used. There being 0.11 per cent manganese (Mn) in the soil used, concentrations of 0.22 per cent, 0.55 per cent, and 1.10 per cent Mn, respectively, were established. That is to say, the percentage of manganese with soil was increased to 2, 5, and 10 times its original value. Another set of the same concentrations was made to which the amount of lime required to neutralize the soil as shown by the Veitch method (11) was applied. Manganese chloride and manganese sulfate were added in solution. The manganese dioxide was added as a powder and thoroughly mixed with the soil.

After the soil had been prepared and the fertilizer added, the rice was planted. The tenth day after germination the plants were thinned to six plants to a can, and a week later to four.

Careful observations were made on the growth of the plants with special emphasis on the effects of the different compounds and of their concentrations. Table I gives the observations on the growth of plants as recorded from time to time. For the check cans and for those treated with manganese compounds but not with lime, Table II shows the yield both of grain and straw and the numbers of culms and panicles in the various cans at the time of harvest. Table III indicates the production in grain and straw and the number of culms and panicles for the several check cans, and for those treated with lime alone, as well as those to which both lime and manganese were added.

DISCUSSION OF RESULTS

MANGANESE SULFATE

Without lime.—The effect of manganese sulfate was noticeable earlier than the effect of any other fertilizer used. For the first few weeks, plants in soil containing 0.22 per cent manganese grew faster than the other plants, but by the sixth week they were overtaken by the plants treated with manganese dioxide, without lime. The apparently beneficial effect of the manganese sulfate was confined however to pots with 0.22 per cent manganese, the higher concentrations checking the growth, causing yellowing of the leaves and reduction of the yield.

The highest yield in the series "manganese sulfate without lime" was from the soils with 0.22 per cent manganese. The yield for other concentrations of manganese as sulfate was lower than the yield of plants grown in check pots.

With lime.—It is to be noted that the addition of lime without manganese sulfate seems to be disadvantageous, since plants grown in check pots with lime gave a lower yield than the plants grown in check pots without lime. Other investigators at the College of Agriculture, using the same variety of rice, Tiniaong, found that the application of lime decreased the yield and that for every increase in application there was a corresponding decrease in yield. The deleterious effect of lime seemed to be even more pronounced in the presence of manganese compounds. An increase in the concentration of manganese gave a decrease in yield.

MANGANESE CHLORIDE

Without lime.—Manganese chloride in the concentration of 0.22 per cent manganese seemed favorable to growth rate at first. For nearly two months the growth of plants in pots with 0.22 per cent manganese as chloride rivaled the growth of plants grown in check pots. The concentration of 0.55 per cent killed the plants of the first planting, and the concentration of 1.10 per cent killed all plants in both plantings.

The yield from plants grown in pots treated with manganese chloride was in no case equal to that from the plants grown in the check pots. Plants grown in pots with 0.22 per cent manganese produced more culms than did those in the checks, but the culms were smaller than those of the check plants. The only stimulating action of manganese chloride appeared in these pots; 0.22 per cent manganese as manganese chloride giving an increase in production of straw but a decrease in yield of grain.

With lime.—The effect of manganese chloride and lime was similar to the effect of manganese sulfate and lime. The chloride, however, had a much more pronounced effect than did the sulfate. The effect of manganese chloride with lime at the concentration of 0.55 per cent and 1.10 per cent manganese was similar to the effect of manganese chloride when used alone at the same concentration.

MANGANESE DIOXIDE

Without lime.—The manganese dioxide proved markedly beneficial. All plants grown with all concentrations of manganese dioxide gave greater yields than the plants grown in check pots.

Unlike manganese sulfate and manganese chloride which showed their effects very early, manganese dioxide gave a very gradual and continuous effect, increasing from the start up to when the plants were about to flower. Manganese dioxide proved beneficial, also, in its effect on production of grain and straw. All the plants in pots treated with manganese dioxide gave better growth and yields than the plants in the checks and the yields increased with the increase in concentration.

With lime.—It was further shown in this series that the beneficial effect of manganese seemed to be counteracted by the presence of lime. The results, both in growth and production, with lime and manganese dioxide were in the same order as those without lime but the former were lower than for the limed checks and the results from all the limed cans were much poorer than those from the checks without lime.

In this experiment, the most favorable concentration for growth and production of rice was about 1.10 per cent manganese in the form of manganese dioxide, without lime.

CONCLUSIONS

1. Manganese dioxide, sulfate, and chloride at certain concentrations all proved beneficial to the growth of rice and to the yield of both grain and straw.

2. The optimum concentration for stimulation of plant growth varied with the particular manganese compound.

3. The lowest concentration of manganese sulfate used in this experiment was the only one giving seemingly beneficial results, higher concentrations of the salt proving harmful. It is possible that still lower concentrations would be even more beneficial.

4. Manganese chloride in the concentration of 0.22 per cent manganese gave a decrease in yield of grain but an increase in the production of straw.

5. Manganese dioxide without lime in the proportion used in this experiment proved beneficial to growth and increased the yield in all cases.

6. Increase in concentration of manganese dioxide gave an increase in yield. Possibly the concentrations given by Leoncini (12) (0.035–2.2 per cent Mn) would work still more effectively.

7. Lime seems to counteract any beneficial effect of manganese on rice, and to accentuate its detrimental effects.

RECOMMENDATIONS

The writer recommends the continuation of this study both in water and pot cultures to determine the effect upon successive crops of single applications of manganese compounds. The effect of continued application of manganese compounds upon the productivity of the soil should also be studied.

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TABLE I.—*Giving observations on growth of rice.*

Date.	Observations.
Oct. 9, 1920	Planted.
Oct. 14, 1920	Germinated.
Oct. 17, 1920	Thinned.
Oct. 21, 1920	Plants in MnO_2 with lime containing 0.55% and 1.10% Mn showed yellowing of leaves. Other plants were vigorous. $MnSO_4$ (0.22% Mn) as fertilizer showed up best.
Oct. 26, 1920	Plants in pots containing 0.55% and 1.10% Mn as $MnSO_4$ and $MnCl_2$ were wilting. Plants in limed pots were smaller; leaves rolled.
Oct. 31, 1920	Plants in pots with 1.10% Mn as $MnCl_2$ both limed and unlimed were dying. The most vigorous plants were those grown in 0.22% Mn as $MnSO_4$.
Nov. 6, 1920	The plants in pots with 1.10% Mn as $MnCl_2$, both limed and unlimed, were replanted, also those of 0.55% Mn in same set.
Nov. 9, 1920	The plants in replanted pots were doing well.
Nov. 12, 1920	Plants in pots with 1.10% Mn as $MnCl_2$, both limed and unlimed, were dying.
Nov. 15, 1920	Plants in 1.10% Mn as $MnCl_2$ died. Limed plants were smaller than those receiving no lime. The plants in checks and in pots with MnO_2 without lime and those in 0.22% Mn as $MnCl_2$ were good. Increase in concentration of both $MnSO_4$ and $MnCl_2$ reduced vigor of plants. Increase in concentration with MnO_2 as fertilizer without lime shows increase in vigor of plants. The best growing plants were those in 0.22% Mn as $MnSO_4$, all plants grown in MnO_2 without lime and check.
Nov. 18, 1920	Effect the same, only becoming more pronounced.
Nov. 21, 1920	Plants with 0.22% Mn as $MnSO_4$, 0.22% Mn as $MnCl_2$, varying concentrations of MnO_2, without lime, all showed signs of bearing flowers.
Nov. 24, 1920	Plants with 0.22% Mn as ($MnSO_4$) flowered.
Nov. 25, 1920	Plants with 0.22% Mn as ($MnCl_2$) flowered.
Nov. 26, 1920	Plants with 1.10% Mn as MnO_2 flowered.
Nov. 27, 1920	Plants in checks 3 and 6 flowered.
Nov. 28, 1920	Plants in 0.22% and 0.55% Mn as (MnO_2) flowered.
Nov. 30, 1920	All plants, except those in limed pots receiving $MnCl_2$ and MnO_2 and 1.10% Mn as $MnSO_4$ limed, had flowers.
Dec. 1, 1920	No noticeable change in progress of growth.
Dec. 6, 1920	Plants with 1.10% Mn as $MnSO_4$ (limed) have flowers.
Dec. 11, 1920	Plants doing well.
Jan. 5, 1921	Harvested all, except plants in limed pots with $MnCl_2$, MnO_2 and 1.10% Mn as $MnSO_4$.
Feb. 2, 1921	All harvested.

TABLE II.—*Showing production as affected by concentrations of the different manganese compounds.*

Fertilizers.	Pot number.	Percentage conc.	Weight.				Average weight of grain and straw.	Culms.		Panicles.	
			Grain.	Average.	Straw.	Average.		Number.	Average.	Number.	Average.
			gm.	*gm.*	*gm.*	*gm.*	*gm.*				
Check	1	.11	13.83	16.04	21.46	28.40	43.95	17	17.0	12	14.5
"	4	.11	18.26		35.33			17		17	
"	2	.11	14.40	18.93	21.34	22.89	41.82	13	14.5	11	12.5
"	5	.11	23.45		24.43			16		14	
"	3	.11	21.85	17.37	26.29	25.68	43.04	14	13.5	14	11.5
"	6	.11	12.88		25.07			13		9	
Averages				17.28		25.69			15.0		12.17
$MnSO_4$	1	.22	17.98	19.38	29.24	28.67	48.05	14	15.0	10	10.0
"	2	.22	20.78		28.10			16		10	
"	1	.55	8.62	11.04	30.30	26.34	37.38	18	17.0	12	10.
"	2	.55	13.46		22.38			16		8	
"	1	1.10	5.61	7.27	17.96	18.83	26.12	10	11.0	8	7.
"	2	1.10	8.92		19.70			12		6	
$MnCl_2$	1	.22	7.83	12.57	33.70	26.80	39.37	17	16.5	11	12.5
"	2	.22	17.30		19.90			16		14	
"	1	.55	1.50	4.98	10.13	13.41	18.39	6	14.0	2	12.5
"	2	.55	8.45		16.69			22		17	
"	1	1.10	—	—	—	—	—	—	—	—	—
"	2	1.10	—	—	—	—	—	—	—	—	—
MnO	1	.22	22.76		35.23			21		16	
"	2	.22	19.78	21.27	27.40	31.32	52.56	16	18.5	12	14.0
"	1	.55	22.81	22.59	25.56	28.17	50.76	16	18.0	12	13.0
"	2	.55	22.36		30.78			20		14	
"	1	1.10	32.76	27.46	38.83	35.73	61.37	24	22.0	21	19.0
"	2	1.10	22.15		32.62			20		17	

TABLE III.—*Showing production as affected by concentration of the different manganese compounds with lime.*

Fertilizers.	Pot number.	Percentage conc.	Weight.				Average weight of grain and straw.	Culms.		Panicles.	
			Grain.	Average.	Straw.	Average.		Number.	Average.	Number.	Average.
			gm.	*gm.*	*gm.*	*gm.*	*gm.*				
Check with lime	1	.11	15.76	12.45	20.64	16.74	29.16	19	15.5	18	14.0
	2	.11	9.15		12.84			12		10	
	1	.22	14.91	11.93	20.23	16.42	28.35	12	10.0	10	8.5
	2	.22	8.95		12.60			8		7	
$MnSO_4$ + $CaCO_3$	1	.55	4.57	9.31	12.79	15.59	24.88	9	9.5	6	7.0
	2	.55	14.04		18.39			10		9	
	1	1.10	6.43	7.49	19.37	17.24	24.18	16	13.0	10	8.0
	2	1.10	8.55		15.11			10		6	
	1	.22	2.77	2.45	7.27	7.12	19.56	10	10.0	6	7.0
	2	.22	2.12		6.97			10		8	
$MnCl_2$ + $CaCO_3$	1	.55	1.65	2.09	7.55	7.99	10.10	13	13.5	8	9.0
	2	.55	2.53		8.42			14		10	
	1	1.10	—	—	—	—	—	—	—	—	—
	2	1.10	—		—			—		—	
	1	.22	3.05	2.75	18.42	13.47	16.22	25	19.5	20	13.5
	2	.22	2.45		8.51			14		7	
MnO_2 + $CaCO_3$	1	.55	5.22	3.91	15.45	12.54	16.35	15	12.0	11	8.0
	2	.55	2.60		9.43			9		5	
	1	1.10	5.53	4.53	15.13	12.78	17.31	18	14.0	13	10.0
	2	1.10	3.52		10.43			10		7	

ABSTRACT[1]

The Helminthosporium disease of rice occurring in the southern United States and in the Philippines. GERARDO OFFIMARIA OCFEMIA. *The American Journal of Botany* **11**: 385-408. *Pls. 22-27.* 1924.—The paper reports the results of the pathological portion of the work on the Helminthosporium disease of rice (*Oryza sativa* L.) occurring in Louisiana and in the Philippines. The work was conducted in the Department of Plant Pathology of the University of Wisconsin from October, 1920, to March, 1923.[2]

In the present paper the author reports that the Helminthosporium disease of rice occurs in Java, Sumatra, Japan, China, India, Straits Settlements, and Federated Malay States, Italy, the Philippine Islands, and, at least, in Louisiana in the southern United States. The paper states that the severity of the disease varies in different places probably on account of climatic conditions. It is reported that the disease occasions losses of 10 to 58 per cent in the Philippines. In Louisiana no actual count of the loss was made but from the writer's observations the disease occurs on all varieties of rice in culture there, although it is practically unrecognized.

The symptoms of the disease are reported as leaf spots on seedlings and older plants, seedling and leaf blight, infections of culms and sheaths, and to some extent infection of the glumes. The disease causes total blasting of kernels in cases of severe infection of the panicles. In all cases many of the apparently healthy grains have seed-borne mycelium. If grains with seed-borne mycelium are planted, seedling blight results. As soon as the invaded parts of the rice seedlings die, sporulation takes place and conidia are spread by the wind causing secondary infections.

Taxonomic studies made by comparing the causal fungus on specimens collected from various parts of the world including Japan, India, Java, and Sumatra show that the Helminthosporium disease of rice in the Philippines and in Louisiana is caused by one and the same organism, *Helminthosporium oryzae* Breda de Haan. This fungus was first described by Van Breda de Haan in Java in 1900. Miyabe and Hori redescribed it in Japan in 1901. The different strains, however, have certain morphological and physiological differences.

The species of the Helminthosporium causing the disease in China, in the Straits Settlements, and Federated Malay States is not definitely known.

Both the Philippine and the Louisiana strains of *H. oryzae* studied by the writer have the following morphological characteristics:

The mycelium is light brown, fine, fairly uniform in width, branched, septate, varying in width from 3 to 8 μ. The length of the cells varies from 140 to 440 μ.

The conidiophores are aërial in fascicles of two to four, dark brown, lighter-colored towards the apex, slightly constricted at the base, with the basal cell swollen, more or less flexuous, 7– to 26–septate, and 200–600 $\times$ 4–8 μ.

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[1] Experiment Station contribution No. 254.

[2] The results of the work on the relation of soil temperature to germination of certain Philippine upland and lowland varieties of rice and the infection by Helminthosporium disease referred to in the *abstract* appeared in July issue of the *American Journal of Botany*. Abstract will appear in January issue of the PHILIPPINE AGRICULTURIST.

The conidia are borne apically or on knee-like projections on the sides of the conidiophores. They are light brown or olivaceous, slightly lunate, fusoid, fusoid-cylindrical, obclavate, or clavate, 5– to 11–septate, not constricted at the septa, with contents finely granular, obtuse at both ends, readily detached, 45–120 × 10–20 μ, germinating at both extremities, occasionally germinating in the middle cells.

The conidiophores germinate readily. Penetration of germ tubes into rice tissues may be direct or through natural openings.

The author reports from cultural studies conducted that the fungus sporulates sparingly on artificial media. It is claimed that frequently sporulation may be secured on plant tissues, especially on the cotton which has been bathed in the decoction of the plant tissue used. The author reports having produced sporulating strains of *H. oryzae* in this manner. Only the sporulating strains of *H. oryzae* from Louisiana and from Japan are said to produce conidia on different carbohydrates including some of the rare sugars, added to water agar, and on glycerine agars. The Philippine non-sporulating cultures produced conidia on glycerine agars.

Experiments conducted to determine the relation of temperature to the growth of the fungus in pure culture showed that *H. oryzae* grows best at 28° C. The maximum temperature is about 40° C., and the minimum is about 16° C. The exact temperatures for the maximum and minimum were not determined.

The author found that the fungus may be induced to sporulate on ordinary 1.5 per cent potato-dextrose agar by irritation of the mycelium and by partial dessication, either in the sun or in artificial light, using 220-volt electric lamps, at temperatures above the optimum for growth.

It was found that the best vegetative development of *H. oryzae* on potato-dextrose agar was obtained at a pH– concentration of 8.6–8.8, and only bare growth of the mycelium was obtained at a pH– concentration of 2.4–2.6. The maximum alkalinity of the medium which will allow growth was not determined.

Dissection of apparently healthy rice grains showed the presence of the mycelium of the fungus on and within the palea and lemma of the grains and even in the ovary walls. The hyphae are attached to the tissues of the rice by means of star-shaped appresoria. The fungus is reported to overwinter on the palea and lemma and on the ovary walls of rice grains. These hyphae are said to be responsible for the greater part of the primary infections in the field.

Pure cultures of the Philippine and Louisiana strains of *H. oryzae* were compared with the Japanese strain in artificial inoculation work and they showed that they are pathogenic on germinating seedlings and on all parts of the rice in its different stages of development. In inoculation of aërial parts of the rice the symptoms appeared in 20 to 24 hours. In artificial cross inoculation work it was possible to infect 31 species of Gramineae belonging to 23 genera. Of these 31 species, 23 distributed among 17 genera have not been reported by Japanese investigators to be infected by *H. oryzae*.

The paper states that so far as known, *H. oryzae* does not produce the perfect stage. Conidia are produced throughout the rice growing season. The conidia are carried by the wind causing secondary infection on all parts of the rice plant during its entire life history, that is, from seedling to the maturity of the grains.

On account of the semi-saprophytic habit of *H. oryzae*, it is advised to practice proper sanitary measures as these will aid in reducing the sources of infection in the field.

During the progress of the work it was noted that certain varieties of rice are more resistant to the Helminthosporium disease than others. No work, however, was done to determine the extent and duration of the apparent difference in degree of susceptibility.

In this review reference is made to experiments the results of which appeared in a second paper in the *American Journal of Botany* (see footnote). According to the results, it is stated that possibly infection from *H. oryzae* overwintering in the soil and in crop residue may be reduced by seeding in soil at a temperature of about 36° C., or by starting seedlings in seed beds at this temperature. It was found that at 36° C., rice germinates in two to three days after planting, with very light infection, but this temperature is not suitable for the subsequent development of the seedlings. At 32° C. rice germinates as fast as at 36° C., and the temperature is around the optimum for the subsequent development of the seedlings. Occasional blighting of the seedlings, however, occurs at 32° C. Also the growth and development of the lesions at 32° C. are very rapid, perhaps because of the rapid growth of both the fungus and the rice at this temperature.

During the course of the work it was also found that Philippine lowland varieties of rice and Honduras, a lowland variety from Louisiana, emerged through water 10 to 20 centimeters deep at temperatures from 24° C. to 28° C. As to the fungus overwintering in the soil and crop residues it seems probable that infection can be prevented by submerging soil in water to a depth of about ten centimeters providing the temperature of the water is 24° C. to 28° C. If the water is deeper than 10 centimeters the seedlings produced are spindling. The conidia mixed with the soil at planting or suspended in the water did not infect the rice seedlings.

—*Abstract by G. O. Ocfemia.*

EXCHANGE NOTES

A motion picture on phases of the rice industry, entitled "Rice, from Paddy to Bowl," has just been released by the department. This film, one of the department's series of educational pictures, shows methods of harvesting and handling rice that tend to improve the quality of the product and enhance its market value.

Many people living in the northern part of the United States believe that all the rice sold at the local grocery store is grown in China or elsewhere in the Orient. On the contrary, as this film shows, the United States in 1923, for example, produced over 22,200,000 bushels of rough rice, enough not only to supply all the demands for rice in this country, but also a considerable additional amount for export to other countries.

Photography for "Rice from the Paddy to the Bowl" was made in the rice fields of the lower Mississippi valley and in mills in that region.

—The *Official Record*, (U. S.).

Two prize-winning definitions of "home". First one by a boy, second by a girl.

"Home is a place my father is proud to support, my mother is glad to keep, and my friends are happy to visit."

"Home is the first place I think of when I'm either sad or glad."

—*Extension News Service* (N. Y. College of Agriculture.)

Question.—Why is it that Latin and Greek are the languages from which the scientific names of plants have been derived?

Answer.—There are two principal reasons why the scientific names of plants are taken from Latin and Greek. One is that botany is a world-wide science, and it is necessary to have names for plants which can be used and understood by botanists of all countries. We could not expect a German or a Frenchman to call a certain plant "daisy," and we would not be willing to call it "ganseblume" or "paquerette". Classical Latin and Greek, being "dead languages," can be used by botanists of all countries without doing violence to their patriotic feelings. A second very important reason for the use of scientific names is found in the precision they give. Not only are different popular names given to the same plant, but the same name is given to different plants in different regions. The name "daisy," to take an example, is applied in England to *Bellis perennis*, but in this country usually refers to *Chrysanthemum leucanthemum*. The latter plant is called "ox-eye" in England, but in this country that name usually refers to *Heliopsis helianthoides* or *Helenium autumnate*, and it is also used for plants of at least five other genera. Scientific names, on the other hand, are the same in every language, and at once indicate the plant intended without possibility of confusion.

—The *Extension Letter* (University of Hawaii).

An Agricultural College differs from a purely academic institution in that it must take into account the world as it is, and not merely the world as it might be or ought to be. In contradistinction to the University, an Agricultural College has, or should have, an industrial, social, almost an organic connection with certain well-defined fields of human activity, and experience has shown in most developed countries that the success of Agricultural Colleges very largely depends upon the solidarity of this connection, upon the extent to which the College really enters into the life and work of the agricultural communities it is designed to serve. But before this connection can be established there must exist both within the College and amongst the external communities a sufficiently well-developed standard of general education, or at all events, of actively intelligent interest.

—*Tropical Agriculture.*

Exports of lumber from the Philippines to Japan amounted to 4,569,024 board feet during 1923 compared with 282,808 for 1922.

There is some demand for the Lauan types of lumber for shipment to Japan. It is expected that the emergency use of Philippine lumber will create a regular demand in Japan.

—*Commerce Reports,* (U. S Department of Commerce).

The largest production of Pineapples in the world is in the Hawaiian Islands where the industry has become a very large one.

Last year 6 million cases of canned Pineapples were exported. * * * All the fields now are mulched with a paper mulch, consisting of fine strips laid like a carpet through the fields, and this special paper is made locally from cane megass.

—The *Journal of the Jamaica Agricultural Society.*

The German margarine industry is passing through a rather critical period of readjustment because of the tendency in a considerable portion of the consuming population to use butter rather than lard and margarine for table use. * * *

Before the war there were only 116 margarine factories in Germany. This number was increased to 180 with a monthly capacity of 40,000 tons in 1923. * * * At present one-third of the factories in operation in 1923 have closed. * * *

—*Crops and Markets* (U. S.).

At the statutory meeting (in London) of Rubber Streets and Tennis Courts (Ltd.), it was stated that there was no satisfactory hard court at present, and that many leading lawn tennis experts believe that the rubber surface court promises to provide an ideal playing ground. If the theoretical advantages claimed are realized in practice, the firm believes there will be a great and immediate demand for rubber tennis courts. The company is proceeding in the preparation of molds for tennis courts and progress has been made in the acquisition of sites. * * * Experimental work on rubber paving for roadways is also being carried on.

—*Commerce Reports,* (U. S. Department of Commerce).

COLLEGE AND ALUMNI NOTES

His Excellency, Governor General Wood, was the guest of the College on Loyalty Day. He reviewed the cadets and addressed the Student Body.

A mounted globe now stands in our Library. It bears the inscription "Presented by Sam F. Trelease, Professor of Botany, College of Agriculture, 1917-20." It warms the cockles of our hearts, faculty and students both, to know that Doctor Trelease still remembers us. No danger of our forgetting "Doctor Sam". Faculty and students are deeply grateful for this generous gift. It will do yeoman's service for the students in learning "The 'appy roads that take you o'er the world."

Hon. Masaji Inouye and Mrs. Inouye of Tokyo were recent visitors at the College of Agriculture. Mr. Inouye is a member of the Japan House of Representatives and Mrs. Inouye is Dean and Professor of Household Science in Japan Women's University. The understanding interest in our institution and its work shown by Mr. and Mrs. Inouye was most gratifying.

Among other recent visitors who came for the avowed purpose of finding out what we are actually doing, were Mr. Carson Taylor, Publisher of the *Manila Daily Bulletin*, and Mr. Walter H. Robb, Secretary of the American Chamber of Commerce.

Prof. D. A. Herbert, Head of the Department of Plant Physiology and Editor of PHILIPPINE AGRICULTURIST since June, 1922, resigned to accept a position in the Department of Biology in the University of Queensland, Brisbane, Australia. Professor and Mrs. Herbert sailed for Australia on October 3.

Dr. Leopoldo B. Uichanco, Acting Head of the Department of Entomology, and Miss Mercedes Alejandrino of Gerona, Tarlac, were married September 29. The bride is a graduate of the School of Pharmacy of the University of the Philippines and recently passed the Board Examination.

Loyalty Day, October 10, our own Special Day, was observed with unusual dignity this year. This was the sixth anniversary of the day when the entire student body and faculty offered, through the Philippine National Guard, their services to the United States and Allied Powers in the World War.

The Los Baños regiment, three hundred and fifteen cadets, in the morning at 8:30, formed in column of squads along the road passing in front of the Catholic Church, with the head of the column at the road-crossing at the Veterinary College. The regiment headed by the Constabulary Band marched to the parade

ground. The regiment was formed at 9:30 sharp, and the military ceremonies began. The colors were escorted. After the colors were received by the regiment, parade followed. After the parade the regiment was reviewed by His Excellency, the Governor General of the Philippines. The following were among the visitors in the reviewing stand: President Palma, University of the Philippines; Major Read, Cavalry, U. S. Army, and Military Aide to the Governor General; Major H. F. Hazlette, 31st U. S. Infantry, who came as chief judge for the competition in company drill; Captain John McBride, Commandant, University of the Philippines; and Captain Baja of the Philippine Constabulary, Executive Officer, Philippines Reserve Officers Training Corps, University of the Philippines. These officers accompanied the Governor General when he inspected the regiment.

Competition in company drill began at 2:00 o'clock in the afternoon. The following were the judges: Major Hazlette, 31st U. S. Infantry, Chief Judge; Major Velasquez of the Philippine Constabulary, Member; and Lieutenant Burgos of the Philippine Constabulary, Member. Company C, commanded by Cadet Captain Isidoro Andaya, with Cadet Lieutenants Villanueva and Nolledo as platoon leaders, was the winner of first place. Company G (Forest School Company) under the command of Cadet 1st Lieutenant Isabelo Miguel, with Cadet Lieutenants Reyes and Cabiling obtained the second place.

At the convocation which was held under the shade of the flame trees, brief and stirring addresses were made by Governor General Wood, President Palma, Dean Baker, and Commandant, Captain McBride. Many of Mr. Pedro Rodrigo's "Reminiscences of a Guardsman" provoked laughter not alone from former "buddies," but from the whole audience. Mr. Irineo Sevilla, President of the Student Body, presided.

Among the visitors entertained by the faculty at luncheon at the residence of Doctor Gonzalez were: President Palma, Hon. Tomás Confesor, Dean Kalaw, Dean Bocobo, Doctor Scott, Head, English Department, College of Liberal Arts, Commandant, Captain McBride, Major Hazlette, Major Velasquez, P.C., Lieutenant Baja, P.C., Lieutenant Burgos, P. C., and Mr. Quisumbing.

Barbecue lunch for other visitors was served on the Campus.

The principal number of a recent "Y" program was a play "Coming Events" written and directed by Prof. E. Gertrude Madison of the English Department. The motif of the play was the change of attitude taking place regarding the social position of the farmer in the Philippines. The young men who took the parts of the *Señoritas* in the play received many compliments for admirable impersonation as well as appearance.

The *Makiling Echo*, Vol. III, No. 3, the quarterly publication (mimeographed) of the Forest School, was recently received. From the artistic cover page to the last page on which appears Professor Cuzner's Ranger's Song it is a most creditable number. The leading articles are: "Touring the Islands with the Provincial Governors" by Prof. C. A. Neff; "Geology and Soils in Relation to Forestry" by Forester R. F. Wendover; "Manufacture of Charcoal by the Japanese Process" by Ranger Constantino Rabaya.

We note with pleasure that "The Stone Rejected" by Dean Baker, our editorial in the June number, was given a prominent place in the *Echo*.

Mr. Mamerto E. Limuaco, '24, was a visitor at the College not long ago. Mr. Limuaco is starting a cattle ranch near Pagsanjan, Laguna, his home town. He says that he has 30 head of cattle. Mr. Limuaco majored in animal husbandry and was one of the active members of the Ranchers' Club when he was in College.

"One of the most outstanding beauties of Hongkong, besides her buildings, is her roads. Such magnificent roads that non-asphalted roads are very conspicuous by their absence," writes Mr. Alex. Gordon, '23, en route to the United States, to Dean Baker. In Japan, Mr. Gordon was "amazed to see such intensive cultivation going on. The hillsides are checked with paddies."

Mr. Epifanio Enerva, '24, writes Doctor Fronda that he is in charge of poultry and swine in San Carlos Farm School, Pangasinan Province.

Mr. Elias M. Caray, M.S., '24, writes from Batangas High School: "I enjoy my work here, teaching physics, biology, and advanced algebra. There is one thing I am glad I am developing—'system' in teaching."